GW – 028

FACILITY-WIDE GW MONITORING WORK PLAN

2012

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June 28, 2012

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Our ref:
TX000836.0004

Subject:
2012 Facility Wide Groundwater Monitoring Work Plan
Navajo Refining Company, Artesia Refinery
EPA ID#: NMD048918817
HWB-NRC-10-001

Dear Mr. Cobrain and Mr. Chavez:

ARCADIS is submitting the enclosed annual update to the Facility Wide Groundwater Monitoring Work Plan (FWGMWP) on behalf of the Navajo Refining Company (Navajo). This update has been prepared and is being submitted according to the requirements of the Post-Closure Care Permit issued by the New Mexico Environment Department (NMED) Hazardous Waste Bureau. The FWGMWP also incorporates the requirements of the Discharge Permit issued by the New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Division. The updated FWGMWP is being submitted in both hard copy and electronic format.

Sincerely,

ARCADIS U.S., Inc.

Pamela Krueger
Senior Project Manager

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2012 Facility Wide Groundwater Monitoring Workplan
NMD048918817
and DP GW-028

Prepared for:
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Hazardous Waste Bureau

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Acronyms and Abbreviations

bgs	Below Ground Surface
CMI	Corrective Measures Implementation
DO	Dissolved Oxygen
DRO	Diesel Range Organics
EP	Evaporation Ponds
EPA	Environmental Protection Agency
GRO	Gasoline Range Organics
HSWA	Hazardous and Solid Waste Amendment
mg/L	milligrams per liter
mm	millimeters
MTBE	Methyl tert butyl ether
NCL	North Colony Landfarm
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
OCD	Oil Conservation Division
ORP	Oxygen Reduction Potential
PCC	Post Closure Care
ppm	parts per million
PSH	Phase Separated Hydrocarbons
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVOC	Semivolatile Organic Compounds
TDS	Total Dissolved Solids
TEL	Tetra ethyl lead
TMD	Three Mile Ditch
VOC	Volatile Organic Compounds
WQCC	Water Quality Control Commission

Executive Summary

The Navajo Refining Company (Navajo) owns and operates the Artesia Refinery (Refinery), which is located in Artesia, New Mexico. The facility has been in operation since the 1920's and processes crude oil into asphalt, fuel oil, gasoline, diesel, jet fuel and liquefied petroleum gas. The refinery has a processing capacity of 100,000 barrels of crude oil per day.

In October 2003, the Secretary of the New Mexico Environment Department (NMED) issued a Post-Closure Care Permit (PCC Permit) for the Artesia Refinery, which has U.S. Environmental Protection Agency (EPA) ID Number NMD048918817. The PCC Permit was modified in December 2010. Among other action items, the PCC Permit authorizes and requires Navajo (the Permittee) to conduct facility wide groundwater monitoring. The purpose of the groundwater monitoring program is to evaluate for the presence, nature and extent of hazardous and regulated constituents pursuant to Section 20.4.1.500 of the New Mexico Administrative Code (NMAC) and the Water Quality Control Commission (WQCC) standards included in 20 NMAC 6.2.

The New Mexico Oil Conservation Division (OCD) issued a renewal to Discharge Permit GW-028 dated August 20, 2008. Among other requirements, the Discharge Permit requires semiannual facility wide groundwater monitoring and submittal of an annual report summarizing the groundwater monitoring and remediation conducted throughout each year.

This update to the Facility Wide Groundwater Monitoring Workplan (FWGMWP) is being submitted as per the requirements of Section 4.7.6.a of the updated PCC Permit. This FWGMWP is an update of the previous workplan submitted to NMED and OCD in June 2011 and revised in September 2011. The purpose of this FWGMWP is to direct the observation and characterization of the nature and extent of groundwater contamination beneath or migrating from the Refinery. This FWGMWP contains all groundwater monitoring activities that will be conducted to satisfy both the NMED PCC Permit and the OCD Discharge Permit requirements.

The groundwater monitoring program is focused specifically on monitoring the following areas:

- The closed Tetra Ethyl Lead (TEL) Impoundment;
- The inactive North Colony Landfarm (NCL);

- The inactive Evaporation Ponds (EP);
- Three Mile Ditch (TMD); and
- The impacted vadose zone located beneath the Refinery, extending east along the direction of flow.

This FWGMWP follows the general outline suggested for a workplan provided in Appendix E of the PCC Permit, while incorporating the requirements of Sections 20 and 22 of the Discharge Permit.

1. Introduction

The Navajo Refining Company (Navajo) owns and operates the Artesia Refinery, which is located in Artesia, New Mexico (Figure 1). The facility has been in operation since the 1920's and processes crude oil into asphalt, fuel oil, gasoline, diesel, jet fuel and liquefied petroleum gas.

In October 2003, the Secretary of the New Mexico Environment Department (NMED) issued a Resource Conservation and Recovery Act (RCRA) Post-Closure Care Permit (PCC Permit) for the Artesia Refinery, which has U.S. Environmental Protection Agency (EPA) ID Number NMD048918817. The PCC Permit was modified in December 2010. Among other action items, the PCC Permit authorizes and requires Navajo (the Permittee) to conduct facility wide groundwater monitoring. The purpose of the groundwater monitoring program is to evaluate for the presence, nature and extent of hazardous and regulated constituents pursuant to Section 20.4.1.500 of the New Mexico Administrative Code (NMAC) and the Water Quality Control Commission (WQCC) standards included in 20 NMAC 6.2.

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- The inactive Evaporation Ponds (EP)
- Three Mile Ditch (TMD); and
- The impacted vadose zone located beneath the Refinery, extending east along the direction of flow.

The closed TEL Impoundment is located near the eastern boundary of the active Refinery and south of Eagle Creek (Figure 2). The inactive NCL is located near the northwestern corner of the Refinery (Figure 2). The inactive EP area is located approximately three miles east of the active Refinery, south and west of the Pecos River. The impacted vadose zone is located beneath the Refinery and extends to the east from the active Refinery in the direction of groundwater flow.

This FWGMWP describes the planned activities that will be conducted in 2012 to continue monitoring the groundwater and continue interim recovery of phase separate hydrocarbons (PSH). The format of this FWGMWP follows the general outline specified for a workplan in Appendix E of the PCC, while incorporating the requirements of Sections 20 and 22 of the Discharge Permit.

2. Background

Navajo operates a 100,000 barrel-per-day petroleum Refinery located at 501 East Main Street in the city of Artesia, Eddy County, New Mexico. The facility has been in operation since the 1920's and processes crude oil into asphalt, fuel oil, gasoline, diesel, jet fuel, and liquefied petroleum gas. The refinery is an active, growing industrial facility. There are no plans to close the facility or reduce the size of the operation.

In recent years Navajo has made significant investments in the facility to increase production, make low sulfur gasoline and diesel and other clean fuels, and reduce air emissions. While not possible to accurately predict the lifespan of the facility, it has been in operation for over 80 years and could easily remain in operation for that many more years given the demand and supply for refined fuel products in the U.S.

The Artesia Refinery is regulated under the Resource Conservation and Recovery Act (RCRA), having EPA ID Number NMD 048918817. The NMED issued a Hazardous Waste Facility Permit to Navajo effective August 21, 1989.

Included as part of the 1989 Hazardous Waste Facility Permit was a Hazardous and Solid Waste Amendment (HSWA) Permit issued by the EPA. This permit required Navajo to identify all historical and current non-hazardous SWMUs and investigate those that had the potential to pose a threat to human health or the environment. SWMUs which pose a potential threat must undergo additional investigation (a RCRA Facility Investigation [RFI] and possibly Corrective Measures Implementation [CMI]) to minimize the threat.

Following completion of the Phase I RFI in December, 1990, it was agreed by EPA and NMED that additional investigations were required for the Three Mile Ditch (TMD) and Evaporation Ponds (EPs) located east of the refinery. The second phase of investigation of those areas was conducted from 1991 through 1993, resulting in the RFI Phase II Report finalized in November, 1993. A final Phase III Investigation Report addressing comments from the EPA and NMED was submitted in January 1996 along with a proposed workplan for removal of waste soils from TMD. In December 1997, a consolidated report was submitted to NMED that summarized the various investigations performed up to that time along with recommendations for corrective actions in the TMD and the EP areas.

At the request of NMED, Navajo submitted a Post-Closure Permit Application in June 1998. The original intent of this application, to address only closure and post-closure activities at the EPs and TMD, was expanded to include a complete RCRA Permit renewal application.

The Secretary of the NMED issued a Post-Closure Care Permit (PCC Permit) to Navajo Refining Company, the owner and operator of the Artesia Refinery Facility (EPA ID number NMD 048918817) effective October 5, 2003. The PCC Permit was modified in December 2010. The PCC Permit authorizes and requires the Permittee to monitor the groundwater, maintain all groundwater monitoring wells and comply with applicable regulations of 20.4.1.500 NMAC during the post-closure period. Specific groundwater monitoring requirements are included in the PCC Permit for the areas of the TEL Impoundment, the NCL, the EP area, and other areas identified through implementation of the investigations of various SWMUs.

The OCD issued a renewal of Discharge Permit GW-028 dated August 20, 2008. The Discharge Permit authorizes and requires the Permittee to maintain PSH recovery systems and to conduct semiannual groundwater monitoring. The Discharge Permit requires submittal of an annual report summarizing the results of the monitoring and recovery programs.

In 2006, Navajo submitted a Groundwater Monitoring Workplan that combined the requirements of the two permits into a comprehensive monitoring program. An updated Groundwater Monitoring Workplan was submitted in June 2011 and submitted in revised form in September 2011. This FWGMWP is the annual update of the workplan, as required by Section 4.7.6.a of the PCC Permit. This Workplan includes a revised monitoring schedule based on changes to the groundwater monitoring network and a critical evaluation of the sample parameters, as described in the following sections.

3. Site Conditions

3.1 Surface Conditions

3.1.1 Area Land Uses

The area north, south and east of the facility is sparsely populated and used primarily for agricultural and ranching purposes. The primary business and residential areas of the City of Artesia are located to the west, southwest and northwest of the Refinery. There are a few commercial businesses south of the Refinery along Highway 82, including an oil-field pipe company located at the southeast corner of the plant. Much of the property for one-half mile north to East Richey Avenue and east toward Bolton Road is owned by Navajo. Much of the area east and northeast to Haldeman Road is a cultivated pecan orchard or used for other agricultural and ranching purposes.

The active Refinery and much of the surrounding property owned by Navajo is fenced and guarded with controlled entry points.

3.1.2 Topography

The Refinery is located on the east side of the City of Artesia in the broad Pecos River Valley of Eastern New Mexico. The topography of the site and surrounding areas is shown in Figure 1. The average elevation of the city is 3,380 feet above mean sea level. The plain on which Artesia is located slopes eastward at about 20 feet per mile.

3.1.3 Surface Water Drainage Features

Surface drainage in the area is dominated by small ephemeral creeks and arroyos that flow eastward to the Pecos River, located three miles east of the city. The major drainage in the immediate area of the site is Eagle Creek (or Eagle Draw), an ephemeral watercourse normally flowing only following rain events, that runs southwest to northeast through the northern process area of the Refinery and then eastward to the Pecos River. Upstream of the Refinery, Eagle Draw functions as a major stormwater conveyance for the community. It also drains outlying areas west of the city and is periodically scoured by intense rain events.

Natural surface drainage at the Refinery is to the north and east. Stormwater within the process areas is captured and routed to the Refinery wastewater treatment system. Stormwater from non-process areas is contained within the Refinery property inside

stormwater berms and routed to stormwater retention basins. Stormwater from within the Refinery boundary is not allowed to discharge to Eagle Draw.

The elevation of Eagle Draw is 3,360 feet at its entrance to the Refinery and decreases to approximately 3,305 feet at its confluence with the Pecos River. Eagle Draw was channelized from west of Artesia to the Pecos River to help control and minimize flood events. In the vicinity of the refinery, the Eagle Draw channel was cemented to provide further protection during flood events. A check dam was also constructed west of Artesia along Eagle Draw. Federal floodplain maps indicate that most of the city and the refinery have been effectively removed from the 100 year floodplain.

3.2 Subsurface Conditions

3.2.1 Soils

Soils at the Refinery are primarily of the Pima and Karro series. Soils characterized for permitting the NCL were about 60% Pima and 40% Karro soils. The Pima and Karro soils have similar properties. Pima soils are deep, well drained, dark colored, calcareous soils, which occur on floodplains of narrow drainageways (e.g. – Eagle Creek). These soils have moderate shrink-swell potential and were subject to periodic flooding. Runoff from Pima soils is slow, permeability is moderately low and the water-holding capacity is high. The effective rooting depth is greater than five feet and the water table is deeper than five feet.

The Karro soils are highly calcareous. Calcium carbonate typically accumulates as caliche at a depth of about 45 inches. These soils are found on level to gently sloping terrains and are susceptible to wind erosion. Runoff is slow and water-holding capacity is high. Permeability is moderate and the effective rooting depth and depth to groundwater are both over five feet.

3.2.2 Regional Geology

Navajo Refinery is located on the northwest shelf of the Permian Basin. In this region, the deposits are comprised of approximately 250 to 300 feet of Quaternary alluvium uncomformably overlying approximately 2,000 feet of Permian clastic and carbonate rocks. These Permian deposits uncomformably overlie Precambrian syenite, gneiss and diabase crystalline rocks. The relationships between the sedimentary deposits are discussed below.

3.2.2.1 Quaternary Alluvium

The Quaternary alluvium in the Refinery area is dominantly comprised of clays, silts, sands and gravels deposited in the Pecos River Valley. These "valley fill" deposits extend in a north-south belt approximately 20 miles wide, generally west of the Pecos River. The thickness of the valley fill varies from a thin veneer on the western margins of the Pecos River valley to a maximum of 300 feet in depressions, one of which is located beneath the Refinery. These depressions have resulted from dissolution of the underlying Permian carbonates and evaporites. The sedimentology and mineralogy of the valley fill deposits can be divided into three units: the uppermost carbonate gravel unit, the interbedded clay unit, and the underlying quartzose unit.

The carbonate gravel unit blankets the other valley fill units and forms a fairly uniform slope from the Permian rock outcrop areas on the west side of the Permian Valley east to the Pecos River floodplain. The unit consists of coarse-grained carbonate gravel deposits along major drainage ways to the Pecos River, which grade into brown calcareous silts and thin masses of caliche in the interstream regions. The carbonate gravel unit includes the Orchard Park, Blackdom and Lakewood terrace deposits of Fielder and Nye as well as Holocene and Pleistocene Pecos River alluvial deposits.

The agricultural land around Artesia is part of the Orchard Park terrace deposit, which forms a thin veneer overlying older valley fill alluvium. The Orchard Park terrace surface gently rises in elevation to between 5 and 25 feet above the Lakewood terrace. The Orchard Park is generally less than 20 feet in thickness in the Refinery area and is comprised of silt interbedded with poorly sorted lenses of mixed size pebbles in a silt and sand matrix. Chalky caliche commonly occurs in the upper layers.

The Blackdom terrace is about 40 to 50 feet in elevation above the Orchard Park terrace west of Artesia. However, the deposits associated with the Blackdom terrace are generally less than 20 feet in thickness. The Blackdom terrace deposits are coarser grained than the deposits associated with the Orchard Park and Lakewood terraces. In addition, the caliche soils have a higher density than those developed on the Orchard Park terrace.

The Lakewood deposits, the lowest of the three terrace units, are essentially the current alluvial sediments in the floodplain along the river. They consist of brown sandy silt interbedded with lenses of gravel and sand and some localized caliche in higher parts. The Lakewood terrace is confined to the area immediately adjacent to

the river and is underlain by Pleistocene alluvium deposited by the Pecos River and its tributaries.

The clay unit is not laterally continuous throughout the valley fill deposits, but occurs in isolated lenses generally overlying the quartzose unit. The clay unit is comprised of light-to-medium-gray clays and silts deposited in localized ponds and lakes. These ponds and lakes may have formed in conjunction with dissolution and collapse of the underlying Permian rocks.

The quartzose unit consists primarily of fragments of quartz and igneous rocks cemented by calcium carbonate. This unit is laterally contiguous throughout the Pecos River Valley and is generally less than 250 feet thick. The quartzose unit unconformably overlies Permian Rocks and lower quartzose gravels are commonly used for groundwater production.

3.2.2.2 Permian Artesian Group

The Permian Artesian Group is comprised of five formations (from shallowest to deepest): the Tansill, Yates, Seven Rivers, Queen and Grayburg Formations. The Tansill and Yates Formations outcrop at the surface east of the Pecos River and are not present in the vicinity of the Refinery.

The uppermost Permian formation in the Artesia area is the Seven Rivers Formation, which outcrops east of the Pecos River. This eastward-dipping formation is eroded and buried by the valley fill alluvium at a depth of 300 feet in the area between the river and the Refinery. Nearer the Refinery, the formation thins and disappears farther west. Where the formation is present, it consists of a sequence of evaporites, carbonates, gypsum and shale with isolated sand and fractured anhydrite/gypsum lenses.

An examination of available borehole logs by IT Corporation, in the mid-80s provided no indication that the Seven Rivers formation has been encountered beneath the Refinery. However, the lithologic logs of wells completed in the Refinery area describe unconsolidated alluvial deposits from depths of about 20 feet to over 250 feet.

In the area of the Refinery, the Queen and Grayburg Formations have been mapped as a single unit by geologists as consisting of about 700 feet of interbedded dolomite and calcareous dolomite, gypsum, fine-grained sandstone, carbonates, siltstone and mudstone. In locations where the Seven Rivers Formation is absent, the upper portion

of the Queen Formation acts as a confining bed between the deep artesian aquifer and the valley fill aquifer.

3.2.2.3 San Andres Formation

The San Andres Formation lies beneath the Grayburg and Queen Formations and immediately above the Precambrian crystalline basement rocks. The San Andres Formation is composed mainly of limestone and dolomite containing irregularly and erratic solution cavities, which range up to several feet in diameter. Its thickness is greater than 700 feet. The upper portion of the formation is composed of oolitic dolomite with some anhydrite cement.

3.2.3 Regional Groundwater

The principal aquifers in the Artesia area are within the San Andres Formation and the valley fill alluvium. A near-surface water-bearing zone is present in the vicinity of the Refinery process area, which is apparently limited in vertical extent, is shallow with respect to the surface, but exhibits artesian properties at some monitoring wells. The deeper carbonate aquifer is referred to as the deep artesian aquifer, whereas the water-bearing zones of the shallower valley fill alluvium are referred to as the shallow saturated zone and the valley fill zone.

3.2.3.1 Shallow Saturated Zone

Lithologic logs from monitor wells installed within and near the Refinery document a near-surface saturated zone overlying the main valley fill alluvium and containing water of variable quality in fractured caliche and sand and gravel lenses at depths of 15 to 30 feet below ground surface. This water is under artesian pressure for at least some or most of the year with static water levels 3 to 5 feet above the saturated zones.

Figure 2 depicts the monitoring wells installed in the area of the Refinery and the Evaporation Ponds east of the Refinery. Isopleths of the potentiometric surface, as measured in September and October 2011 in the shallow saturated zone, are shown in Figure 3. The general direction of flow in this near-surface saturated zone is to the east toward the Pecos River.

Locally, this uppermost water zone is likely connected to Eagle Creek west of the Refinery and most likely discharges to marshes and shallow alluvium along the west side of the Pecos River. The most probable sources of the water are thought to be

recharge from Eagle Creek and lawn watering runoff from the grass-covered urban park that occupies the Eagle Creek Channel immediately upstream of the Refinery.

The water in the shallow saturated zone is highly variable in quality, volume, areal extent and saturated thickness. Concentrations of total dissolved solids (TDS) exceeding 2,000 milligrams per liter (mg/L) and sulfate exceeding 500 mg/L have been recorded on the northwest side of the Refinery near the NCL.

As reported in the *2011 Annual Groundwater Report* (ARCADIS, March 2012), the shallow groundwater beneath the Refinery and beneath the EPs is impacted with constituents typically associated with hydrocarbons. Concentrations of the organic constituents in the shallow groundwater exhibit a stable or declining trend in most locations (ARCADIS, March 2012).

Recharge of the shallow water bearing zone is generally attributed to irrigation return flow from pumpage of the aquifers and from infiltration from the Pecos River. The general direction of groundwater flow in the shallow saturated zone follows the regional stratigraphic dip eastward toward the Pecos River, then southward subparallel to the river.

3.2.3.2 Valley Fill Zone

Quaternary alluvial deposits of sand, silt, clay and gravel are the main components of the valley fill zone. These sediments are about 300 feet thick in the area between the City of Artesia near the Refinery and the Pecos River. The three principal units in the valley fill are the carbonate gravel, clay and quartzose.

The carbonate gravel unit, described in an earlier section, is the uppermost alluvial unit in the valley fill. Coarse-grained gravels deposited in the major tributaries to the Pecos River grade to calcareous silts and thin zones of caliche in the interstream areas. Near the surface, groundwater is localized in thin discontinuous gravel beds typical of braided channel material deposited during flood events originating in the foothills and Sacramento Mountains to the west.

Irrigation and water production wells completed in the valley fill zone typically are screened across from one to five water-producing zones. Thicknesses of up to 170 feet have been reported for water-production zones, but most are less than 20 feet. Producing zones are principally sand and gravel separated by less permeable lenses of silt and clay. Wells in the valley fill range from 40 to 60 feet below ground level and

the formation yields water containing 500 to 1,500 parts per million (ppm) TDS. The average transmissivity of the alluvium has been estimated at 100,000 to 150,000 gallons per day per square foot.

Eighteen monitoring wells have been installed in the valley fill zone in the vicinity of the refinery and the evaporation ponds. In areas of the valley where the San Andres aquifer and valley fill zone are hydraulically connected in the subsurface, water tends to flow up from the deep aquifer to the shallow water bearing zones, except in areas of heavy San Andres pumpage. Adjacent to the Pecos River, the valley fill alluvium contains groundwater beginning at a depth of 6 to 12 feet. The alluvium is predominately silty sand, which possibly contains lenses of higher permeability material.

Silt and clay deposits in the valley fill zone are not continuous, but occur as isolated lenses, generally overlying the quartzose unit. Most logs of wells located immediately to the north and east of the Refinery show considerable thicknesses of clays or clay mixtures. However, these clays may be more closely related to the fine-grained materials of the carbonate gravel unit found in the interstream areas between the major drainage ways.

The thickness of these clay/clay mixtures ranges from 20 to 160 feet. The intervals of occurrence differ from well to well, and thin zones or gravels are interspersed in the upper 100 feet. Drillers seeking deep artesian water drill through the valley fill zone and usually log large intervening zones as "clay and cap". This lack of detail makes it difficult to correlate specific zones of coarse-grained sediments within the silt and clay deposits.

The quartzose unit is considered the primary production unit in the valley fill zone. Away from the Pecos River, the unit consists of fragments of sandstone, quartzite, quartz chert, igneous and carbonate rocks. The fragments range from medium grained (1/4 mm) to pebble size (16 mm) and are commonly cemented with calcium carbonate. By contrast, in the vicinity of the river, the unit contains principally medium to coarse uncemented quartz grains.

3.2.3.3 Deep Artesian Aquifer

The deep artesian aquifer is closely related to the Permian San Andres Limestone and generally consists of one or more water producing zones of variable permeability located in the upper portion of the carbonate rocks. However, in the Artesia area, the

producing interval rises stratigraphically and includes the lower sections of the overlying Grayburg and Queen formations. Near the Refinery, the depth to the top of the producing interval is estimated to be about 440 feet. The Seven Rivers formation and the other members of the Artesia Group are generally considered confining beds although some pumpage occurs locally from fractures and secondary porosity in the lower Grayburg and Queen members.

The deep artesian aquifer has been extensively developed for industrial, municipal and agricultural use. The quality of water from this aquifer ranges from 500 ppm to more than 5,000 ppm TDS depending on location. In the Artesia area, water is generally derived from depths ranging from 850 feet to 1,250 feet below ground surface. The aquifer recharge is in the Sacramento Mountains to the west of Artesia. Extensive use of this aquifer in recent decades has lowered the potentiometric head in the aquifer in some locations from 50 to 80 feet below ground level, although extensive rainfall in some years may bring the water levels in some wells close to the surface.

Information available for irrigation well RA-4798 indicates that it is screened at 840 to 850 feet below ground surface, in the deep artesian aquifer. Historic analytical data from this well does not indicate the presence of hydrocarbon impacts from refinery operations.

4. Modifications to the Groundwater Monitoring Network

This section of the FWGMWP discusses the modifications to the groundwater monitoring network that have occurred since submittal of the 2011 FWGMWP.

4.1 New Monitoring Wells

No new monitoring wells were installed since the June 2011 FWGMWP update was submitted.

4.2 Well Abandonments

No monitoring wells were abandoned since the June 2011 FWGMWP update was submitted.

4.3 Well Repairs

Repairs were made to monitoring well MW-42 and recovery well RW-2 in early 2012. Monitoring well MW-42 was knocked over and damaged by equipment. The concrete pad and the surface casing were replaced and resurveyed. Recovery well RW-2 was also knocked over and the riser pipe was broken. The riser pipe and concrete pad were both replaced. Both the top-of-casing elevations and the land surface elevations for these well were re-surveyed by a registered surveyor.

5. Scope of Services

This section of the FWGMWP provides a detailed description of groundwater monitoring activities to be conducted.

5.1 Health and Safety Considerations

Groundwater monitoring activities will be performed in both active and historic process areas of the refinery, in the inactive EP area, along Three Mile Ditch, and in agricultural fields adjacent to the refinery. The primary health and safety considerations associated with the monitoring activities include the potential for the presence of harmful vapors and environmental hazards.

Any deviations from proposed sample collection procedures due to health and safety considerations will be documented and discussed in the annual monitoring report.

5.2 Routine Monitoring Activities

The groundwater monitoring program includes the following activities:

- Semiannual gauging of monitoring and recovery wells.
- Semiannual collection of analytical samples from monitoring wells as well as from select recovery and irrigation wells.
- Collection and disposal of purge water generated during sample collection and decontamination water generated during gauging and sample collection.

5.3 Groundwater Sample Analyses

5.3.1 2011 Groundwater Analytical Requirements

The 2011 FWGMWP included the following general sampling and analysis plan described below:

- All active and accessible monitoring and recovery wells will be gauged semiannually with an oil/water interface probe to monitor the presence and thickness of PSH and to measure the depth to groundwater and total depth of each well.

- Monitoring wells that contain PSH, as indicated by an oil/water interface probe, will not be sampled during any event that PSH is present with a thickness of 0.03 feet or greater.

- Monitoring wells located along or near the downgradient edges of the impacted areas will be sampled semiannually.

- Select monitoring wells within the impacted areas will be sampled semiannually to monitor the concentrations within the dissolved phase plume areas. The wells selected to be sampled on a semiannual basis should provide adequate information to assess the fate of dissolved phase constituents within known impacted areas.

- Wells within the center of impacted areas will be sampled annually to monitor the concentrations throughout the dissolved phase plume areas.

- Upgradient wells will be sampled annually.

- Active and accessible irrigation wells will be sampled either semiannually or annually.

- Recovery wells will be sampled annually, if PSH is not present or is present with a thickness of less than 0.03 feet.

- Selected wells completed in the deeper valley fill zone will be sampled biennially, beginning in the spring of 2011.

The 2011 FWGMWP required wells to be analyzed for some or all of the following parameters:

- Volatile organic compounds (VOCs) by EPA Method 8260;

- Diesel Range Organics (DRO) by EPA Method 8015B;

- Gasoline Range Organics (GRO) by EPA Method 8015B;

- Total Metals (arsenic, barium, chromium, lead, selenium, iron, manganese, mercury, nickel and vanadium);

- Dissolved Metals (arsenic, barium, chromium, lead, selenium, iron, manganese, nickel and vanadium) – to be analyzed only in the samples collected during the spring events;
- Cyanide;
- Major cations and anions;
- Total dissolved solids; and,
- Nitrates/nitrites.

Not all wells were required to be analyzed for all of the parameters listed above. For instance, the wells designated "KWB" are not required to be analyzed for GRO. Table 1 of the 2011 FWGMWP summarized the analyses performed under that monitoring plan.

5.3.2 Revised Groundwater Monitoring Program

Navajo does not propose any revisions to the general requirements of the monitoring program as part of this FWGMWP. Minor changes to Table 1 have been made based on the most recent presence of PSH in specific wells.

6. Groundwater Sampling Methodology

This section provides a summary of the procedures that will be used to implement this FWGMWP.

6.1 Well Gauging

At the beginning of each semiannual sampling event, all monitoring and recovery wells listed on Table 1 will be gauged to record the depth to PSH (if present), the depth to water, and the total depth of the well. The gauging will be performed using an oil/water interface probe attached to a measuring tape capable of recording measurements to the nearest 0.01 foot. All readings will be made in relation to the marked survey datum at the top of casing of each well. All survey measurements were made at the northern edge of each well casing. In the event that the survey datum mark is not present, the measurements will be made at the top of the well casing, on the northern side of well casing.

In order to provide accurate data for development of groundwater potentiometric surface contours, the groundwater gauging will be performed within two 48-hour periods. All wells located within the Refinery security fence, wells located immediately south of the Refinery and those wells located east of the Southeast Tank Farm will be gauged within one 48-hour period. All remaining wells, including those wells in and near the Evaporation Ponds and those wells between the Refinery and the Evaporation Ponds, will be gauged within a second 48-hour period. Every effort will be made to ensure that the two 48-hour gauging periods are sequential.

Gauging measurements will be recorded on a field gauging form, which consists of a subset of the information contained in Table 1 and is updated for each monitoring event. A typical page of the field gauging form is contained in Appendix A.

Any weather events that occur during and/or between the gauging periods will be recorded on the daily log sheet. A copy of the daily log sheet is provided in Appendix A. The daily log sheets and field gauging forms are provided to the field crew in a bound field logbook.

Data obtained from the gauging will be reported in the annual groundwater monitoring report. The data will be used to develop groundwater contour maps and PSH thickness isopleths, which will also be included in the annual report.

6.2 Well Purging

All zones in each monitoring well shall be purged by removing groundwater prior to sampling in order to ensure that formation water is being sampled. Purging will be accomplished with the use of either a peristaltic or submersible electric sampling pump.

The peristaltic pump will be used where practical to apply low-flow purging and sampling procedures.

The submersible electric sampling pump will be used where the depth to water in a monitoring well is greater than 25 feet (limitation of peristaltic pump) and for sample collection from recovery wells. When this pump is used to purge a well, a minimum of three well casing volumes will be removed. In the event that purge parameters do not stabilize, as specified below, a maximum of 10 well casing volumes will be removed prior to sample collection.

Irrigation wells located on adjacent property are included in the groundwater monitoring program. These wells have dedicated electric pumps and do not have access to allow for gauging of the water level; thus, the volume of water present in the well casing cannot be calculated. If access is available and power is provided to the pump, these wells will be purged using the irrigation pump. Purging will continue until the purge parameters stabilize, as described below.

Purge volumes shall be determined by monitoring, at a minimum, groundwater pH, specific conductance, temperature, dissolved oxygen (DO) concentrations, and oxidation-reduction potential (ORP) during purging. These measurements will be made using appropriate equipment, such as a multiparameter water quality monitoring meter such as a YSI 600XL or similar device, and a flow-through cell. The readings and the volume of water purged between intervals will be obtained at routine intervals during the purging process and recorded on the field log. A sample field log is provided in Appendix A.

Purging will be considered complete when four of the five purge parameters have stabilized. The specified stabilization criteria for pH, temperature and DO are plus or minus 0.2 units (standard pH units for pH, degrees Celsius for temperature, and milligrams per liter for DO), specific conductance is plus or minus 0.02 units (Siemens per meter or milliSiemens per centimeter) and ORP is plus or minus 20 units (millivolts). The units used for measurement of purge parameters will be recorded on the well sampling sheet.

If a well should purge dry, then it will be allowed to recover. When the water level has returned to a minimum of 75 percent of the level measured at the beginning of the sampling event, a sample will be collected for analysis.

The equipment used for the field measurements (such as a YSI multiparameter water quality meter or similar device) will be calibrated at least once during each day of the sampling event. Calibration will be performed according to the equipment manufacturer's directions. Calibration data will be recorded in the daily field notes.

Purged groundwater will be collected and disposed of properly, as described in Section 6.7.

6.3 Groundwater Sample Collection and Handling

Samples will be collected following purging and will consist of pumping groundwater directly into the laboratory provided sample containers. Dedicated tubing will be used for each well to prevent the potential for cross-contamination. Unfiltered samples will be collected for organic and total metals analyses.

Containers will be labeled and placed into appropriate containers (coolers) with ice for shipment to the analytical laboratory. Each label will clearly identify the sample identifier, the date and time of collection, the analytical method to be performed, and the sampler's initials. Separate sample identifications will be used to indicate filtered samples for analysis of dissolved metals.

Shipping containers (coolers) will be packed with ice or similar cooling materials to maintain appropriate sample temperatures. Adequate padding will be provided to prevent breakage or puncture of sample containers during shipment. The containers will be shipped via express courier to the laboratory for analyses. Chain-of-custody forms will be shipped inside each container to properly track the samples in each container. A chain-of-custody seal will be placed on each shipping container and inspected upon arrival at the laboratory to ensure the integrity of the shipped samples.

6.4 Analytical Methods

The groundwater samples will be analyzed for the parameters listed in Table 1, which include the following COCs:

- DRO;
- GRO;
- VOCs;
- Total Metals (arsenic, barium, chromium, iron, lead, manganese and selenium; mercury, nickel, and vanadium in select wells);
- Dissolved Metals (arsenic, barium, chromium, lead, selenium, iron, manganese, nickel and vanadium) – to be analyzed only in the samples collected during the spring events;
- Cyanide;
- Major cations and anions (calcium, chloride, fluoride, potassium, sodium, sulfate);
- Nitrates/nitrites (as nitrogen); and
- Total dissolved solids.

Not all of the COCs will be analyzed for every sample or during every sampling event. Table 1 summarizes which samples will be analyzed for which parameters during each event.

6.5 Quality Assurance/Quality Control Samples

QA/QC samples will be collected to monitor the validity of the sample collection procedures. The following samples will be collected for QA/QC purposes:

- Field duplicates will be collected at a rate of 10 percent, or 1 field duplicate for every 10 groundwater samples. Field duplicates will be analyzed for the same COCs as the parent sample.

- Equipment blanks will be collected from non-dedicated sampling apparatus at a frequency of 5 percent, with a minimum of 1 equipment blank per day. Equipment blank samples will be analyzed for the same COCs as the sample associated with the equipment blank (sample collected immediately prior to the equipment blank). When dedicated sampling materials are used, such as dedicated tubing and a peristaltic pump, no equipment blank samples will be collected.

- Trip blanks will accompany each shipping container (cooler) that contains samples to be analyzed for VOCs.

Laboratory QA/QC samples will be performed according to the EPA test methodologies specified for each method run on a field sample. The laboratory QA/QC samples will include reagent or method blanks, surrogates, matrix spike/matrix spike duplicates, blank spike/blank spike duplicates and/or laboratory duplicates, as appropriate for each method. The laboratory QA/QC samples will be run at the frequency specified by each method.

6.6 PSH Sample Collection

In the event that PSH is present in any of the monitoring wells that have not historically contained PSH, samples may be collected when sufficient volume is present for adequate fingerprint analysis. A minimum of 10 mL is required for fingerprint analysis.

PSH samples will be collected using a hand bailer. The bailer will be lowered into the well slightly into the PSH and water column. The bailer will be slowly removed and groundwater decanted from the bottom of the bailer. The PSH remaining in the bailer will then be placed into the sample container, and the container will be sealed and properly labeled for shipment. Excess groundwater and PSH will be collected and disposed of in the Refinery wastewater treatment system, upstream of the API separator.

6.7 Decontamination Procedures and Investigation Derived Wastes

6.7.1 Liquid Wastes

All reusable groundwater sampling and gauging equipment will be decontaminated prior to coming in contact with the sample media to minimize the potential for cross-contamination of samples. This equipment includes all downhole well gauging devices, submersible pumps, water quality parameter meters and flow-through cell. The equipment will be washed with a brush in a bath of soap and water then rinsed twice with distilled water. The soap and water bath will consist of clean water and a non-phosphate detergent such as Liquinox™ or Alconox™ or similar.

Decontamination fluids will be contained and placed in a 55 gallon drum or similar container for later disposal in the plant wastewater treatment system, upstream of the API separator.

Groundwater removed from each temporary well during development and purging will be containerized in a labeled drum or similar container then disposed of within the plant wastewater treatment system, upstream of the API separator.

Records of the volume of liquid wastes disposed of at the Refinery will be maintained and included in the annual report.

6.7.2 Solid Wastes

Dedicated disposable sampling equipment, including tubing and bailers, will be containerized in appropriate containers, a waste determination will be made, and the waste will be properly disposed of in accordance with applicable requirements. Waste disposal manifests and profiles will be included in the annual monitoring report.

All sampling personnel will wear disposable latex or nitrile gloves while collecting and handling samples. Gloves will be replaced prior to collection of each sample in order to ensure that field-induced cross-contamination does not affect the monitoring results. Gloves will be collected and disposed of along with tubing and bailers, as described above.

7. Reporting

Both the PCC Permit and the Discharge Permit require submittal of an annual report that summarizes the results of the groundwater monitoring program as well as remediation activities conducted for groundwater. Navajo currently submits a combined annual report that meets the requirements of both permits. The report follows the general outline provided in Appendix E of the PCC Permit and incorporates the requirements of 20.B, 22.B, and 22.F of the Discharge Permit.

At a minimum, the report will contain the following:

- Description of groundwater monitoring and remediation activities conducted throughout the reporting period, including sample collection procedures, decontamination procedures, sample handling procedures and management of wastes;
- Summary table of semiannual groundwater and PSH gauging data, with corrected water table elevation for all wells containing PSH;
- Summary table of groundwater quality parameters recorded in the field (purge parameters);
- Summary of laboratory analytical data with comparison to screening levels;
- Summary of QA/QC data review and validation;
- Groundwater contour maps depicting the groundwater gradient for each semiannual monitoring event of the reporting period, including site features and the direction and magnitude of the hydraulic gradient;
- PSH thickness isopleths maps for each semiannual monitoring event during the reporting period;
- Isoconcentration maps for major constituents of concern;
- Plots of static water elevation versus time in key wells, specifically those that contain PSH;

- Tabulation of the monthly and cumulative volume of PSH removed from recovery wells or monitoring wells throughout the reporting period; and

- Recommendations, including any recommended changes to the groundwater monitoring program.

The annual report will be submitted in hardcopy and electronic format to both NMED and OCD for their review.

8. Schedule

The groundwater monitoring program is conducted on a semiannual basis. The first semiannual event will occur no more than 30 days prior to the start of the irrigation season but no later than April 30 of each year. Typically, the first semiannual event occurs in March or April of each calendar year.

The second semiannual event will occur no later than 30 days after the conclusion of the irrigation season or November 15 each year. Typically, the second semiannual event occurs in September or October of each calendar year.

The wells that will be sampled on an annual basis only will be sampled during the first semiannual event of each calendar year.

Wells that are to be sampled biennially will be sampled every other year, beginning in the first semiannual event of 2011. As such, these wells will be sampled during the first semiannual event of 2013 but not during 2012.

Navajo will notify both NMED and OCD at least 15 calendar days prior to the initiation of each semiannual sampling event.

The annual groundwater monitoring report will be submitted to NMED and OCD no later than February 28 of the calendar year following sample collection.

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Tables

Table 1
Revised Monitoring Program and Schedule
Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]									
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
KWB-1A	Monitoring	Downgradient	S of ED, W of BR	Feb-92	2	3353.46	3351.25	33.57	18 to 32	stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
KWB-1B	Monitoring	Downgradient	S of ED, W of BR	Feb-92	4	3352.83	3351.14	34.45	18 to 32	stickup		SA	No analytical samples to be collected									
KWB-1C	Monitoring	Downgradient	S of ED, W of BR	Sep-92	4	3351.38	3351.18	52.51	30.5 to 49.5	stickup		SA	B	B	-	B	B	-	-	B	B	B
KWB-2R	Monitoring	S Refinery	S of US82 on Armstrong & Son		2	3364.32	3364.56	39.90		flush mount	Y	SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
KWB-3AR	Monitoring	Downgradient	S of US82, replaced KWB #3R		2	3347.08	3347.36	33.41		flush mount		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
KWB-4	Monitoring	S Refinery	N of US82, W of BR	Feb-92	2	3370.25	3368.36	41.75	20 to 39	stickup	Y	SA	SA [d]	SA [d]	-	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
KWB-5	Monitoring	S Refinery	N of US82, W of BR	Feb-92	2	3364.72	3362.60	37.69	24.7 to 38.7	stickup	Y	SA	SA [d]	SA [d]	-	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
KWB-6	Monitoring	S Refinery	N of US82, W of BR	Feb-92	2	3360.30	3358.02	36.41	17.5 to 36.5	stickup	Y	SA	SA [d]	SA [d]	-	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
KWB-7	Monitoring	Downgradient	N of US82, between BR & Dirt Rd	Feb-92	2	3346.16	3343.00	34.61	18 to 32	stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
KWB-8	Monitoring	Field E of Refinery	N of US82, between BR & Dirt Rd	Feb-92	2	3350.41	3347.90	- -	15 to 34	stickup	Y	SA	SA [d]	SA [d]	-	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]
KWB-9	Monitoring	Downgradient	S of US82, E of BR	Feb-92	2	3354.53	3351.81	37.26	20 to 34	stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
KWB-10R	Monitoring	Downgradient	S of ED, N of US82	Oct-10	4	3350.97	3351.23	30.15	9 to 29	flush mount	Y	SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
KWB-11A	Monitoring	Downgradient	N of US82, between BR & Dirt Rd	Oct-92	4	3348.72	3346.13	42.03	30 to 39.5	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
KWB-11B	Monitoring	Downgradient	N of US82, between BR & Dirt Rd	Oct-92	4	3348.03	3345.91	72.20	50 to 69.5	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
KWB-12A	Monitoring	Downgradient	S of US82, E of BR	Oct-92	4	3351.81	3352.01	24.85	15.5 to 24.5	flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
KWB-12B	Monitoring	Downgradient	S of US82, E of BR	Oct-92	4	3351.63	3351.84	39.21	25.5 to 39.5	flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
KWB-13	Monitoring	Crossgradient	S of US82, W of BR		2	3365.67	3366.02	33.03		flush mount		SA	A	A	-	A	A	A	A	A	A	A
KWB-P2	Monitoring	Downgradient	E of Dirt Rd, N of US82		2	3338.97	3339.32	33.41		flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
KWB-P3	Monitoring	Downgradient	Art Prod Line		2	3308.50	3305.95	- -		- -		Not included in monitoring program due to distance from impacts										
KWB-P4	Monitoring	Downgradient	Haines House		2	3305.39	3305.76	- -		- -		B	B	B	-	B	-	-	-	-	-	-
KWB-P5	Monitoring	Downgradient	N of US82, E of BR - destroyed by road work									Drop from monitoring program, well destroyed by road work										
MW-1R	Monitoring	EP	W of the EPs		2	3313.28	3311.58	20.56		stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-2A	Monitoring	EP	W of the EPs		2	3312.97	3310.55	17.06		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-2B	Monitoring	EP	W of the EPs		2	3312.49	3309.94	51.74		stickup		SA	No analytical samples to be collected									
MW-3	Monitoring	EP	S of EP 1 & 2		2	3310.32	3309.07	20.11		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-4A	Monitoring	EP	S of EP 1 & 2		4	3312.71	3308.64	22.15		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-4B	Monitoring	EP	S of EP 1 & 2		4	3312.01	3308.73	72.04		stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-5A	Monitoring	EP	S of EP 2		2	3308.62	3306.59	19.79		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-5B	Monitoring	EP	S of EP 2	Dec-92	2	3308.95	3306.71	53.08	41.5 to 50.5	stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-5C	Monitoring	EP	S of EP 2	Jan-95	2	3309.28	3306.55	71.43	59.25 to 68.75	stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-6A	Monitoring	EP	S of EP 1		2	3313.46	3310.40	18.76		stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-6B	Monitoring	EP	S of EP 1		2	3313.35	3310.09	52.00		stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-7A	Monitoring	EP	S of EP 3		2	3309.24	3306.04	17.07		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-7B	Monitoring	EP	S of EP 3		4	3307.87	3306.05	52.17		stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-8	Monitoring	TMD	S of ED between BR & HR	Jun-86	2	3336.42	3334.81	20.11	--	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-9	Monitoring	TMD	S of ED between BR & HR	Jun-86	2	3336.20	3334.50	19.99	--	stickup		SA	No analytical samples to be collected									
MW-10	Monitoring	Downgradient	S of EPs		2	3304.76	3304.14	18.32		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-11A	Monitoring	EP	NE of EP 6		4	3310.76	3308.42	21.75		stickup		SA	A	A	A	A	A	-	-	SA	SA	SA

Revised as of 6/2011.

Table 1
Revised Monitoring Program and Schedule
Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]									
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
MW-11B	Monitoring	EP	NE of EP 6		2	3310.76	3308.34	46.95		stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-12	Monitoring	EP	N of OCD #1		4	3312.73	3310.37	10.38		stickup		SA	Not included in monitoring program due to location (north of river)									
MW-13	Monitoring	EP	N of EP 1		4	3314.24	3311.95	20.82		stickup		SA	Not included in monitoring program due to location (north of river)									
MW-14	Monitoring	EP	E of OCD #7		4	3311.84	3309.44	11.71		stickup		SA	Not included in monitoring program due to location (north of river)									
MW-15	Monitoring	EP	W of EP 1		4	3313.72	3310.97	21.43		stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-16	Monitoring	TMD	E of HR, N of ED		4	3316.12	3313.50	20.98		stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-17	Monitoring	Crossgradient	NE of Artesia POTW		4	3322.01	3319.43	--		stickup		Not included in monitoring program due to distance from impacts										
MW-18	Monitoring	NCL	N Refinery, E of NCL	Jun-82	8	3365.42	3363.06	22.27	15 to 19	stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
MW-18A	Monitoring	EP	S of EPs		4	3308.58	3306.33	22.05		stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
MW-18B	Monitoring	EP	S of EPs		2	3308.74	3306.23	50.24		stickup		SA	B	B	B	B	B	-	-	B	B	B
MW-18T	Monitoring	EP	S of EPs		4	3308.55	3306.30	50.55		stickup		SA	No analytical samples to be collected									
MW-19	Monitoring	NCL	S of NCL		2	3368.00	3366.00	22.00		stickup		SA	No analytical samples to be collected									
MW-20	Monitoring	TMD	E of BR, S of ED	Jan-93	4	3340.91	3338.43	26.61	9.5 to 23.5	stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-21	Monitoring	TMD	S of ED between BR & HR	Jan-93	4	3337.31	3334.65	24.90	7.5 to 22	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-22A	Monitoring	EP	S of EPs		4	3307.62	3305.24	22.33		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
MW-22B	Monitoring	EP	S of EPs		2	3307.63	3305.08	54.31				SA	B	B	B	B	B	-	-	B	B	B
MW-23	Monitoring	N Refinery	W of TEL	Jun-82	6	3368.38	3365.09	19.95	15 to 20	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-24	Monitoring	EP	E of OCD #6	Jul-82	6	3312.85	3310.33	23.25	15 to 20	stickup		SA	Not included in monitoring program due to location (east of river)									
MW-25	Monitoring	TMD / EP	S of ED, E of HR	Jan-95	2	3312.29	3310.35	27.81	15.75 to 25.25	stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-26	Monitoring	TMD	S of ED, E of HR	Jan-95	2	3314.87	3312.08	27.31	15.25 to 24.25	stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-27	Monitoring	TMD	E of HR, S of ED	Jan-95	2	3320.85	3319.46	30.04	18.25 to 27.75	stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-28	Monitoring	S Refinery	E of SE Tankfarm	Jul-82	6	3370.27	3366.79	34.10	25 to 30	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-29	Monitoring	N Refinery	N of TEL	Jan-95	2	3360.64	3359.79	21.82	9.75 to 19.25	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-30	Monitoring	N Refinery / TMD	W of BR		8	3354.33	3353.60	21.35		stickup		SA	No analytical samples to be collected									
MW-39	Monitoring	N Refinery	N of TEL	Jun-84	2	3358.79	3357.94	25.34	14 to 24	stickup	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-40	Monitoring	N Refinery	N of TEL		2	3356.93	3356.56	24.81		stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-41	Monitoring	N Refinery	N of TEL	Jun-84	2	3356.58	3356.38	22.51	14 to 19	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-42	Monitoring	N Refinery	N of TEL		2	3358.44	3355.64	23.40		stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-43	Monitoring	N Refinery	NW of TEL	Jul-84	6	3365.49	3363.38	21.22	15.5 to 20.5	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-45	Monitoring	N Refinery / TMD	E of Refinery, S of ED	Aug-84	2	3351.51	3351.32	15.65	10.5 to 15.5	stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
MW-46R	Monitoring	N Refinery / TMD	E of Refinery, S of ED	Oct-10	2	3350.11	3350.41	19.40	3.5 to 18.5	flush mount		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
MW-48	Monitoring	S Refinery	S of SE Tankfarm		2	3362.97	3363.04	32.47		flush mount	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-49	Monitoring	Central Refinery	E Refinery, midway from ED to US82		2	3359.77	3359.69	33.04		flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-50	Monitoring	Central Refinery	W of Refinery, E of US285, N of US 82		2	3371.05	3368.91	28.27		stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
MW-52	Monitoring	S Refinery	S of Refinery & US82		2	3368.30	3368.36	34.50		flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-53	Monitoring	Upgradient	W of Refinery, E of rail		2	3368.73	3368.86	23.65	13.8 to 23.8	flush mount		SA	A	A	-	A	A	-	-	A	A	A
MW-54A	Monitoring	NCL	NW of NCL		2	3366.49	3363.55	31.06	12.7 to 27.7	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
MW-54B	Monitoring	NCL	NW of NCL		2	3366.47	3363.47	46.80	33.8 to 43.8	stickup		SA	B	B	B	B	B	-	-	B	B	B

Table 1
Revised Monitoring Program and Schedule
Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]								
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
MW-55	Monitoring	N Refinery	E of NCL		2	3364.77	3361.90	26.82	13.7 to 23.7	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-56	Monitoring	N Refinery / TMD	NE of Refinery		2	3357.44	3354.84	26.40	13.4 to 23.4	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
MW-57	Monitoring	Downgradient	S BR		2	3350.91	3350.95	- -		flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-58	Monitoring	Downgradient	S of US82, W of BR		4	3362.22	3362.56	32.90		flush mount	Y	SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
MW-59	Monitoring	N Refinery	Boneyard		2	3354.78	3354.97	29.72		flush mount		SA	A	A	A	A	A	-	-	A	A	A
MW-60	Monitoring	N Refinery	Boneyard		2	3354.33	3354.36	34.30		flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-61	Monitoring	N Refinery	SW of TEL	Apr-05	4	3369.47	3369.45	28.97	14 to 29	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-62	Monitoring	N Refinery	SW of TEL	Apr-05	4	3371.29	3369.01	31.94	14 to 29	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-63	Monitoring	N Refinery	SW of TEL	Apr-05	4			- -	14 to 29	- -	*Damaged during refinery construction*											
MW-64	Monitoring	S Refinery	SW of SE Tankfarm	Apr-05	4	3369.52	3365.56	34.15	15 to 30	flush mount	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-65	Monitoring	S Refinery	S of SE Tankfarm	Apr-05	4	3363.60	3363.84	29.35	14.5 to 29.5	flush mount	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-66	Monitoring	S Refinery	E of SE Tankfarm	Apr-05	4	3363.46	3363.66	29.67	14.6 to 29.6	flush mount		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-67	Monitoring	N Refinery	E of Diesel Tank Farm	Apr-05	4	3365.45	3365.59	27.17	12 to 27	flush mount	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-68	Monitoring	TMD	S of ED, between HR & Dirt Rd		2	3328.21	3325.81	26.51		stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-69	Monitoring	EP	N River, formerly MW #23		2	3313.86	3311.40	10.66		stickup		SA	Not included in monitoring program due to location (north of river)									
MW-70	Monitoring	EP	S of EPs, formerly MW #19		4	3306.30	3303.84	21.77		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
MW-71	Monitoring	TMD	S of ED, formerly MW #29		2	3335.29	3332.99	21.57		stickup		SA	SA	SA	-	SA	SA	SA	SA	SA	SA	SA
MW-72	Monitoring	EP	EP 6	Mar-07	4	3308.45	3306.40	13.70	2 to 12	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-73	Monitoring	EP	EP 3	Mar-07	4	3310.18	3308.02	19.38	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-74	Monitoring	EP	EP 2	Mar-07	4	3310.03	3307.78	19.89	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-75	Monitoring	EP	EP 2	Mar-07	4	3310.21	3307.80	23.45	3 to 18	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-76	Monitoring	EP	EP 2	Mar-07	4	3311.84	3309.70	20.08	3 to 18	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-77	Monitoring	EP	EP 2	Mar-07	4	3310.07	3307.97	20.26	3 to 18	stickup		SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
MW-78	Monitoring	EP	EP 2	Mar-07	4	3310.14	3307.94	19.35	2 to 17	stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-79	Monitoring	EP	EP 5	Mar-07	4	3311.43	3309.08	19.05	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-80	Monitoring	EP	EP 5	Mar-07	4	3310.79	3308.73	19.61	2 to 17	stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-81	Monitoring	EP	EP 5	Mar-07	4	3312.34	3310.19	18.41	2 to 17	stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-82	Monitoring	EP	EP 1	Mar-07	4	3310.75	3308.64	19.77	2 to 17	stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-83	Monitoring	EP	EP 1	Mar-07	4	3310.19	3307.93	19.68	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-84	Monitoring	EP	EP 1	Mar-07	4	3311.59	3309.83	20.21	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
MW-85	Monitoring	EP	EP 1	Mar-07	4	3311.09	3308.99	20.27	3 to 18	stickup	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-86	Monitoring	EP	EP 1	Mar-07	4	3311.06	3308.98	19.28	2 to 17	stickup	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]
MW-87	Monitoring	EP	S of EPs	Mar-07	4	3307.64	3305.42	20.07	2 to 17	stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
MW-88	Monitoring	EP	S of EPs	Mar-07	4	3308.68	3306.43	20.03	3 to 18	stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
MW-89	Monitoring	TMD	S of ED, E of HR	Mar-07	4	3318.32	3316.38	19.99	2 to 17	stickup		SA	A	A	-	A	A	-	-	A	A	A
MW-90	Monitoring	N Refinery	S of Diesel Tankfarm	Jun-07	4	3369.42	3367.13	22.69	5 to 20	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-91	Monitoring	N Refinery	S of Diesel Tankfarm	Jun-07	4	3367.73	3365.72	25.26	7 to 22	stickup	Y	SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-92	Monitoring	N Refinery	S of ED, N of NAPI	Jun-07	4	3368.72	3366.75	22.53	5 to 20	stickup	Y	SA	A	A	A	A	A	-	-	A	A	A

Revised as of 6/2011.

Table 1
Revised Monitoring Program and Schedule
Navajo Refinery Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]									
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
MW-93	Monitoring	N Refinery	S of ED, NE of NAPI	Jun-07	4	3363.79	3364.22	20.10	5 to 20	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-94	Monitoring	N Refinery	SE of Diesel Tankfarm, N of ED	Jul-07	4	3367.97	3365.82	23.79	5 to 20	stickup	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-95	Monitoring	N Refinery	NE of Diesel Tankfarm	Jul-07	4	3368.70	3366.48	25.32	7 to 22	stickup		SA	A	A	A	A	A	-	-	A	A	A
MW-96	Monitoring	N Refinery	S of Diesel Tankfarm	Jul-07	4	3368.92	3366.83	25.47	7 to 22	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-97	Monitoring	N Refinery	SE of NAPI	Jul-07	4	3365.92	3366.38	21.93	8 to 23	flush mount	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-98	Monitoring	N Refinery	E of Former Diesel Storage Tank Area	Jul-07	4	3361.36	3358.96	26.62	13 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-99	Monitoring	S Refinery	NE of Loading Rack	Jul-07	4	3364.07	3362.33	28.26	12 to 27	flush mount	Y	SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-100	Monitoring	S Refinery	SE corner of SE Tankfarm	Jul-07	4	3364.51	3365.11	--	9 to 24	flush mount	*Plugged and abandoned for refinery construction*											
MW-101	Monitoring	S Refinery	E Loading Rack	Jul-07	4	3364.23	3362.07	26.70	8 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-102	Monitoring	S Refinery	E West Firewater Pond	Jul-07	4	3367.64	3365.51	26.44	12 to 27	stickup	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-103	Monitoring	S Refinery	Old Rail ROW	Aug-08	4	3372.47	3370.89	25.10	7 to 22	flush mount		SA	A	A	A	A	A	-	-	A	A	A
MW-104	Monitoring	S Refinery	Old Rail ROW	Aug-08	4	3371.43	3369.41	21.82	3 to 18	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-105	Monitoring	Central Refinery	W of Crude Tankfarm	Feb-09	4	3364.99	3365.20	17.13	8 to 18	flush mount	Y	SA	SA [d]	SA [d]	SA [d]	SA [d]	SA [d]	-	-	SA [d]	SA [d]	SA [d]
MW-106	Monitoring	Central Refinery	E of Crude Tankfarm	Feb-09	4	3358.98	3359.29	22.70	0 to 11	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-107	Monitoring	S Refinery	NE of SE Tankfarm	Feb-09	4	3359.44	3359.63	18.96	12 to 22	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-108	Monitoring	NCL	S of NCL	Jul-09	4	3369.11	3366.25	26.80	9 to 24	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
MW-109	Monitoring	S Refinery	S of Highway 82 at warehouse	Jan-11	2	3368.09	3368.27	30.00	15 to 29.5	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
MW-110	Monitoring	S Refinery	S of Highway 82 at warehouse	Jan-11	2	3368.03	3368.46	30.00	15 to 29.5	flush mount		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
NCL-31	Monitoring	NCL	NCL	Oct-82	2	3367.54	3366.21	20.10	13 to 18	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NCL-32	Monitoring	NCL	NCL	Oct-82	2	3364.91	3364.96	17.31	17 to 22	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NCL-33	Monitoring	NCL	NCL	Oct-82	2	3363.97	3364.26	20.47	13 to 18	stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NCL-34A	Monitoring	NCL	NCL	Oct-82	2	3365.49	3364.82	19.25	16 to 21	stickup	Y	SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NCL-44	Monitoring	NCL	NCL		2	3364.45	3364.01	21.58		stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NCL-49	Monitoring	NCL	NCL		2	3371.13	3368.26	31.98		stickup		SA	SA	SA	-	SA	SA	-	-	SA	SA	SA
NP-1	Monitoring	TMD	S of ED, E of BR		2	3342.40	3339.69	21.64		stickup		SA	SA	-	-	SA	-	-	-	A	A	A
NP-2	Monitoring	TMD	S of ED, E of BR	Jan-93	2	3342.77	3340.58	21.25	9.5 to 18.5	stickup		SA	No analytical samples to be collected									
NP-3	Monitoring	TMD	N of ED, NE of BR	Jan-93	2	3342.93	3340.40	21.65	9.5 to 18.5	stickup		SA	No analytical samples to be collected									
NP-4	Monitoring	TMD	NE of NP #3	Jan-93	2	3345.73	3343.24	36.75	24.5 to 33.5	stickup		SA	No analytical samples to be collected									
NP-5	Monitoring	Crossgradient	S of RR, N of ED, W of BR		2	3349.29	3346.31	24.89		stickup		SA	A	A	-	A	A	-	-	A	A	A
NP-6	Monitoring	TMD	S of ED, W of BR		2	3338.05	3336.31	20.07		stickup		SA	A	-	-	A	-	-	-	-	-	-
NP-7	Monitoring	TMD	In Pecan Orchard, destroyed by landowner			3329.65	3326.84					Drop from monitoring program, destroyed by landowner										
NP-8	Monitoring	TMD	S of ED, E of HR		2	3314.67	3310.53	14.88		stickup		SA	No analytical samples to be collected									
NP-9	Monitoring	TMD	S of RR, N of ED, W of BR		2	3360.62	3357.86	25.86				SA	No analytical samples to be collected									
OCD-1R	Monitoring	EP	NW of EP 6, replaced OCD-1		2	3314.27	3310.69	23.60		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-2A	Monitoring	EP	N of EP 6		2	3314.16	3310.83	27.27		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-2B	Monitoring	EP	N of EP 6		2	3313.07	3310.66	50.58		stickup		SA	No analytical samples to be collected									
OCD-3	Monitoring	EP	NE of EP 6		2	3314.43	3310.89	25.16		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-4	Monitoring	EP	NE of EP 6		2	3313.68	3310.31	25.12		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A

Table 1
Revised Monitoring Program and Schedule
Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]									
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
OCD-5	Monitoring	EP	NE of EP 6		2	3311.27	3308.76	25.13		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-6	Monitoring	EP	E of EP 6		2	3311.40	3308.11	26.51		stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-7AR	Monitoring	EP	SE of EP 6	Dec-92	4	3310.03	3308.86	21.01	5.5 to 19.5	stickup		SA	SA	SA	SA	SA	SA	-	-	A	A	A
OCD-7B	Monitoring	EP	SE of EP 6	Dec-92	2	3310.26	3307.57	56.51	43.5 to 52.5	stickup		SA	B	B	B	B	B	-	-	B	B	B
OCD-7C	Monitoring	EP	SE of EP 6	Jan-95	2	3310.10	3307.74	71.73	60.25 to 69.75	stickup		SA	No analytical samples to be collected									
OCD-8A	Monitoring	EP	SE of EP 3		2	3308.72	3306.43	21.35		stickup		SA	SA	SA	SA	SA	SA	SA	SA	A	A	A
OCD-8B	Monitoring	EP	SE of EP 3		2	3309.19	3306.11	56.24		stickup		SA	B	B	B	B	B	-	-	B	B	B
TEL-1	Monitoring	TEL	E of TEL cap	May-90	2	3358.23	3356.79	26.90	13 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
TEL-2	Monitoring	TEL	E of TEL cap	May-90	2	3359.12	3356.80	27.08	13 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
TEL-3	Monitoring	TEL	E of TEL cap	May-90	2	3358.33	3356.43	27.18	13 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
TEL-4	Monitoring	TEL	W of TEL cap	May-90	2	3360.24	3358.21	27.16	13 to 23	stickup		SA	SA	SA	SA	SA	SA	-	-	SA	SA	SA
UG-1	Monitoring	Upgradient	W of Refinery, James Street	Jul-08	4	3372.94	3373.02	24.01	8 to 23	flush mount		A	A	A	A	A	A	A	A	A	A	A
UG-2	Monitoring	Upgradient	W of Refinery, Roselawn	Jul-08	4	3380.41	3380.30	29.03	15 to 30	flush mount		A	A	A	A	A	A	A	A	A	A	A
UG-3R	Monitoring	Upgradient	W of Refinery, 7th Street	Sep-08	4	3384.08	3384.62	38.32	17 to 37	flush mount		A	A	A	A	A	A	A	A	A	A	A
LaRue Well	Irrigation	Offsite	S of US82	--	--	--	--	--	--	irrigation well		Drop from monitoring program based on historic data (no organic impacts) and lack of consisten										
RA-313	Irrigation	S Refinery	N of US82, W of BR	Oct-40	10	3370.62	3369.96	1157	904 to 1157	irrigation well		NA	A	-	-	A	-	-	-	A	A	A
RA-314	Irrigation	S Refinery	N of US82, W of BR	--	10	3363.82	3363.51	no data	no data	irrigation well		NA	A	-	-	A	-	-	-	A	A	A
RA-1227	Irrigation	SE of Refinery	S of US82, E of BR	Dec-35	10 / 8	3352.80	3352.27	246	194 to 246	irrigation well		NA	SA	-	-	SA	-	-	-	SA	SA	SA
RA-3156	Irrigation	Downgradient	S of US82, E of BR	Nov-53	4	3353.28	3353.02	unknown	182 to ?	irrigation well		NA	SA	-	-	SA	-	-	-	SA	SA	SA
RA-3353	Irrigation	Downgradient	S of US82, E of BR, electricity disconnected 2	--	10	--	--	--	--	irrigation well		Drop from monitoring program since electricity has been cut and well is inoperable										
RA-3723	Irrigation	S Refinery	N of US82, W of BR, inoperable in 2009	--	10	3358.66	3357.33	--	--	irrigation well		Drop from monitoring program since well is inoperable										
RA-4196	Irrigation	Field E of Refinery	N of US82, E of BR	Apr-60	8	3351.52	3350.75	294	280 to 292	irrigation well		NA	SA	-	-	SA	-	-	-	SA	SA	SA
RA-4798	Irrigation	Field E of Refinery	E of BR, N of US82	May-63	7	3348.31	3347.65	850	840 to 850	irrigation well		NA	SA	-	-	SA	-	-	-	SA	SA	SA
RW-1	Recovery [d]	N Refinery	S of ED, NW portion of Refinery		36	3367.03	3365.29	18.73		recovery well	Y	SA	A [d]	A [d]	A [d]	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-2	Recovery [d]	N Refinery	S of ED, NW portion of Refinery		36	3371.29	3368.17	19.28		recovery well	Y	SA	A [d]	A [d]	A [d]	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-3	Recovery [d]	N Refinery	Between ED and TEL, backfilled		36	3364.91	3362.92	--		recovery well		Backfilled, inoperable										
RW-4	Recovery [d]	S Refinery	NW of SE Tankfarm		36	3364.86	3364.41	20.97		recovery well	Y	SA	A	A	-	A	A	-	-	A	A	A
RW-5	Recovery [d]	S Refinery	SE Tankfarm		36	3363.81	3362.79	17.46		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-6	Recovery [d]	S Refinery	W of SE Tankfarm		36	3368.36	3366.03	17.06		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-7	Recovery [d]	N Refinery	N of ED, NW portion of Refinery		36	3367.09	3365.03	20.65		recovery well	Y	SA	A	A	A	A	A	-	-	A	A	A
RW-8	Recovery [d]	N Refinery	N of ED, S of NCL		36	3368.10	3364.89	14.34		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-9	Recovery [d]	N Refinery	N of TEL		36	3359.51	3356.30	21.85		recovery well		SA	A	A	A	A	A	-	-	A	A	A
RW-10	Recovery [d]	N Refinery	N of TEL		36	3360.61	3356.12	23.73		recovery well		SA	A	A	A	A	A	-	-	A	A	A
RW-11 [e]	Recovery [d]	S Refinery	S of US82, W side of BR		36	3353.95	3351.48	22.93		recovery well		SA	A	A	-	A	A	-	-	A	A	A
RW-12	Recovery [d]	Field E of Refinery	N of US 82, W of BR		36	3352.55	3351.17	22.95		recovery well	Y	SA	A	A	-	A	A	-	-	A	A	A
RW-13	Recovery [d]	Field E of Refinery	N of US 82, W of BR		36	3351.95	3349.87	26.21		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-14	Recovery [d]	Field E of Refinery	N of US 82, W of BR		36	3351.48	3347.95	23.75		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]
RW-15 [e]	Recovery [d]	S Refinery	S of SE Tankfarm		36	3361.41	3362.65	21.46		recovery well	Y	SA	A [d]	A [d]	-	A [d]	A [d]	-	-	A [d]	A [d]	A [d]

Revised as of 6/2011.

Table 1
Revised Monitoring Program and Schedule
Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Well Type	Location Information		Well Construction Information [a]							PSH Expected? [b]	Gauging Frequency	Analytical Suite and Frequency [c]								
		Associated Area of Concern	Approximate Location	Date Installed	Diameter (in)	Top of Casing (ft MSL)	Ground Surface (ft MSL)	Total Depth (ft btoc)	Screen Interval (ft bgs)	Surface Finish			Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
RW-16 [e]	Recovery [d]	N Refinery / TMD	NE of Refinery, S of ED		36	3360.97	3357.20	17.52		recovery well		SA	A	A	-	A	A	-	-	A	A	A
RW-17 [e]	Recovery [d]	N Refinery	N of ED, E of NCL		36	3364.72	3362.76	16.00		recovery well		SA	A	A	A	A	A	-	-	A	A	A
RW-18 [e]	Recovery [d]	Field E of Refinery	S of ED, W of BR		36	3350.84	3349.04	17.62		recovery well		SA	A	-	-	A	A	-	-	A	A	A

A = Annual (March/April event)
B = Biennial (starts March/April 2011)
BR = Bolton Road
DRO = Diesel Range Organics
E = East
EP = Evaporation Ponds
ft bgs = feet below ground surface
ft btoc = feet below top of casing
ft MSL = feet Mean Sea Level
GRO = Gasoline Range Organics
HR = Haldeman Road
in = inches
N = North
NA = Not accessible
NAPI = North API Separator
NCL = North Colony Landfarm
NE = Northeast
NS = Not surveyed yet
NW = Northwest
OCD = Oil Conservation District
PSH = Phase Separated Hydrocarbons
ROW = right of way
RR = Richey Road
S = South
SA = Semi-annual (March/April and September/October events)
SE = Southeast
SW = Southwest
TMD = Three Mile Ditch
TEL = Tetra Ethyl Lead Impoundment
UG = Upgradient
US285 = U.S. Highway 285
US82 = U.S. Highway 82
VOCs = Volatile Organic Compounds
W = West
Y = Yes

Footnotes:

[a] Well construction information provided where available. Top of casing and ground surface elevations relative to benchmark G-416. Total depth based on 4/2010 measurements.

[b] *PSH was present during March 2012 groundwater monitoring event or a recovery pump is in place. Note that recovery wells are also gauged at least monthly.*

[c] Analytical Suite to include the following:

1. Purge parameters to be measured and recorded in the field will include pH, temperature, specific conductivity, dissolved oxygen, and oxygen-reduction potential.
2. DRO by Method 8015Mod.
3. GRO by Method 8015Mod.
4. VOCs by Method 8260, to include methyl tert butyl ether (MTBE).
5. Total metals by Method 6010/6020 and/or 7470. Specific metals shown in heading, abbreviations from periodic chart.
6. Dissolved metals - same list as total metals but only analyzed during March/April event
7. Cyanide by Method SM4500.
8. Cations/anions to include Calcium, Potassium, and Sodium by Method 6010 or 6020 and Sulfate, Chloride and Fluoride by Method 300.
9. Nitrates/Nitrites as Nitrogen by Method 300.
10. Total Dissolved Solids by Method 2540C.

"-" indicates parameter not required.

Note - samples will not be collected from any well where PSH is measured to be 0.03 feet thick or greater.

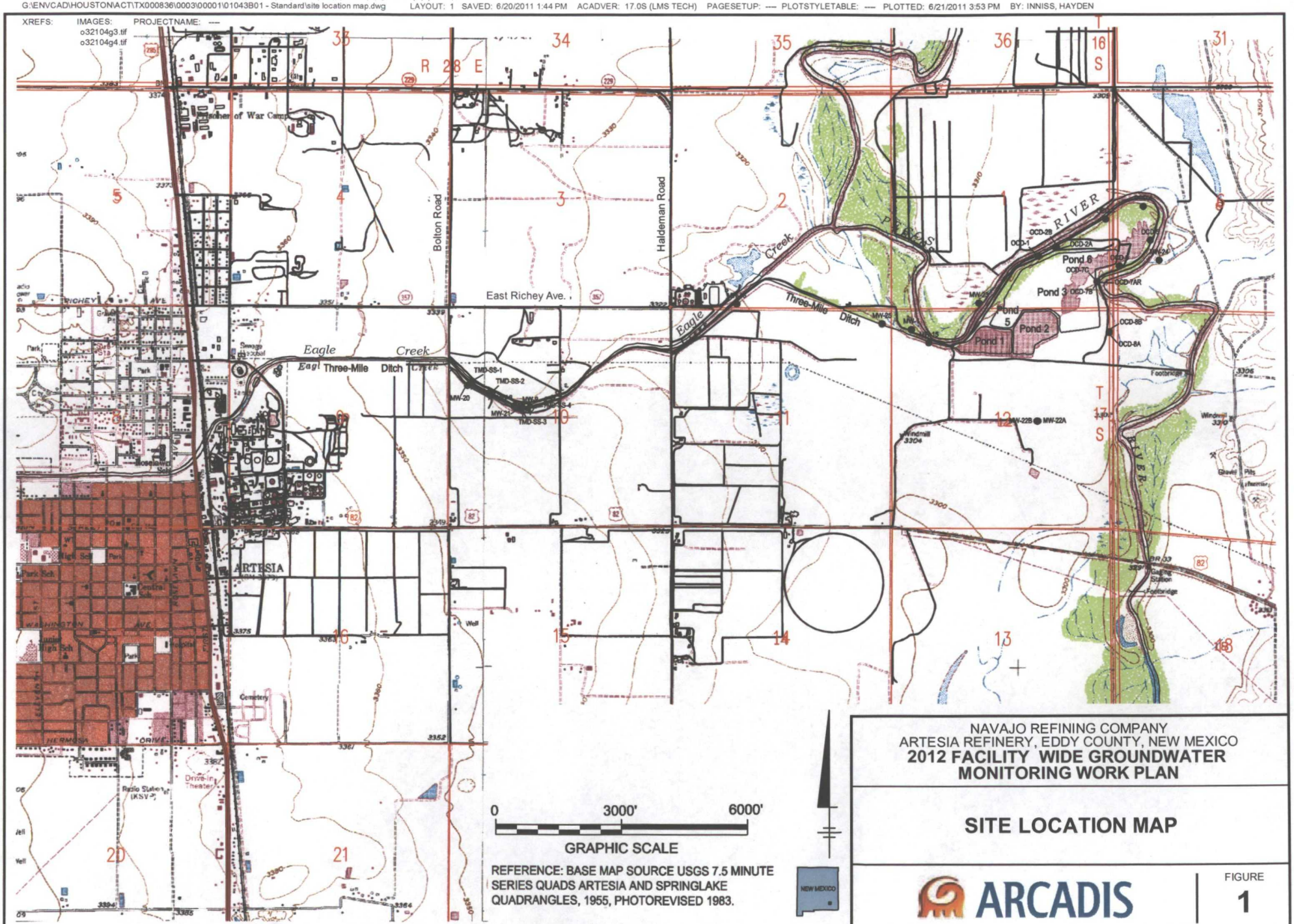
[d] Samples to be collected at frequency indicated if <0.03 feet of PSH is present.

[e] Recovery trenches 11, 15, 16, 17 and 18 have multiple "wells". Gauging and sampling points are as follows: RW #11-0, RW #15C, RW #16B, RW #17A and RW #18A.

ARCADIS

Figures

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\HOUSTON\ACT\TX000836\0003\00001\01043B01 - Standard\site location map.dwg LAYOUT: 1 SAVED: 6/20/2011 1:44 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 6/21/2011 3:53 PM BY: INNISS, HAYDEN
XREFS: IMAGES: PROJECTNAME: ---
o32104g3.tif
o32104g4.tif



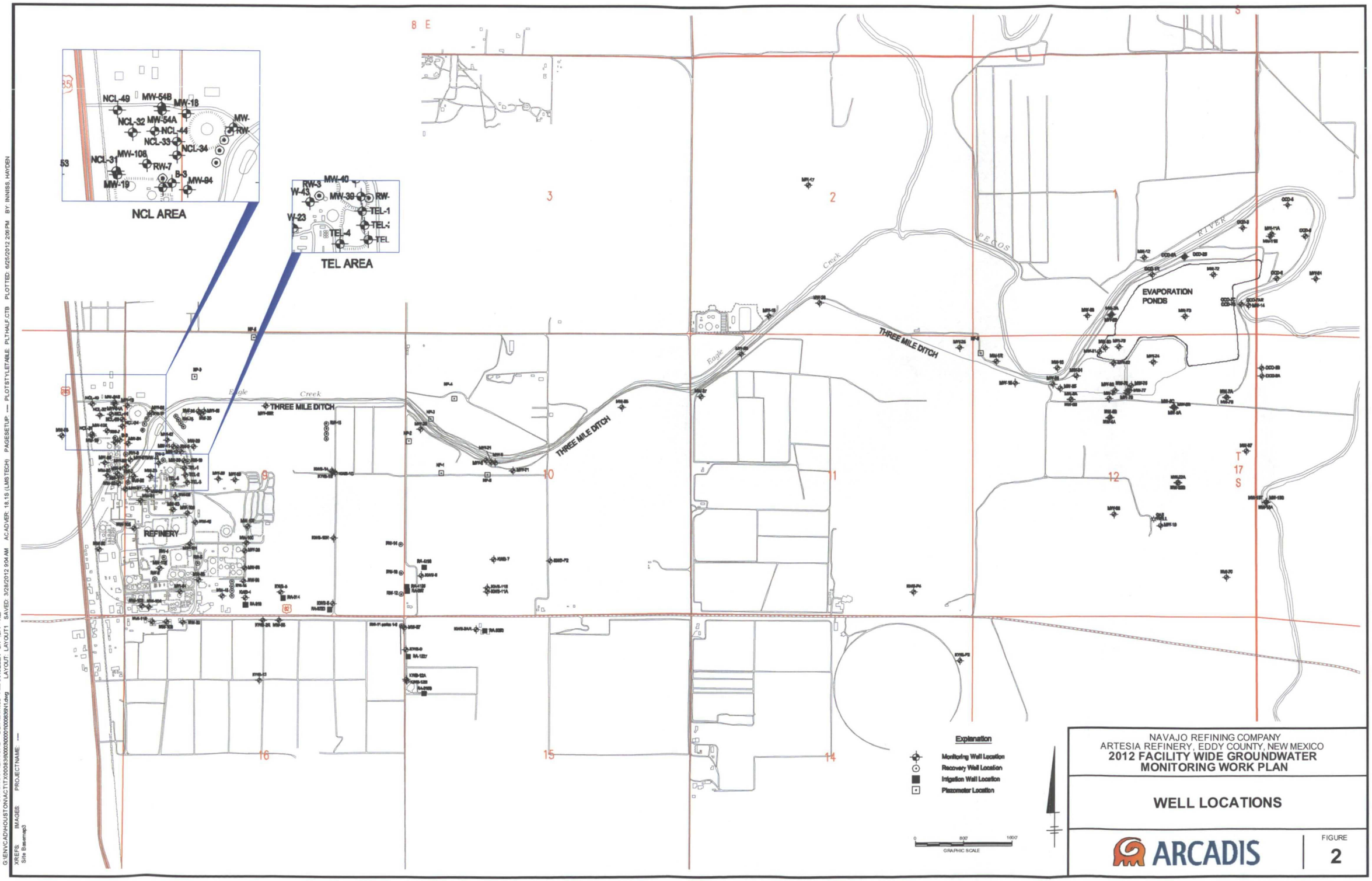
REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE SERIES QUADS ARTESIA AND SPRINGLAKE QUADRANGLES, 1955, PHOTOREVISED 1983.

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO
2012 FACILITY WIDE GROUNDWATER MONITORING WORK PLAN

SITE LOCATION MAP

ARCADIS

FIGURE
1



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO
2012 FACILITY WIDE GROUNDWATER MONITORING WORK PLAN

WELL LOCATIONS

ARCADIS

FIGURE
2

CITY:HOUSTON TX DIV/GROUP:ENVCAD DB:H.INNISS PMP:KRUEGER ON=OFF=REF*
G:\ENVCAD\HOUSTON\ACTIVE\00083\800030001\000830N1.dwg LAYOUT: LAYOUT1 SAVED: 3/28/2012 9:04 AM AC.ADVER: 18.1S (LMSTECH) PAGESETUP: ---
XREFS: IMAGES: PROJECTNAME: ---
Site Basemap3
PLOTTED: 6/25/2012 2:06 PM BY: INNISS, HAYDEN

ARCADIS

Appendix A

Field Forms

September-October 2010 M. .oring Program Summary

Navajo Refining Company - Artesia Refinery, Artesia, New Mexico

Well ID	Diameter (in)	PSH Expected?	Date (2010)	Initials	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Total Depth (ft btoc)	Technician Comments	Purge Parameters	DRO	GRO	VOCs	Metals (As, Ba, Cr, Fe, Pb, Mn, Se)	Metals (Hg, Ni, Va)	Cyanide	Cations/Anions	Nitrates / Nitrites as Nitrogen	Total Dissolved Solids
MW #25	2								-	-	-	-	-	-	-	-	-	-
MW #26	2								-	-	-	-	-	-	-	-	-	-
MW #27	2								-	-	-	-	-	-	-	-	-	-
MW #28	6								X	X	X	X	X	X	X	X	X	X
MW #29	2								X	X	X	X	X	-	-	X	X	X
MW #30	8								No analytical samples to be collected									
MW #39	2	Y							X[a]	X[a]	-	X[a]	X[a]	-	-	X[a]	X[a]	X[a]
MW #40	2								-	-	-	-	-	-	-	-	-	-
MW #41	2								X	X	X	X	X	-	-	X	X	X
MW #42	2								X	X	X	X	X	-	-	X	X	X
MW #43	6								X	X	X	X	X	X	X	X	X	X
MW #45	2								X	X	-	X	X	X	X	X	X	X
MW #46	2								X	X	-	X	X	-	-	X	X	X
MW #48	2	Y							X[a]	X[a]	X[a]	X[a]	X[a]	-	-	X[a]	X[a]	X[a]
MW #49	2								X	X	X	X	X	X	X	X	X	X
MW #50	2								X	X	-	X	X	-	-	X	X	X
MW #52	2								X	X	X	X	X	X	X	X	X	X
MW #53	2								-	-	-	-	-	-	-	-	-	-
MW #54A	2								X	X	-	X	X	-	-	X	X	X
MW #54B	2								-	-	-	-	-	-	-	-	-	-
MW #55	2								X	X	X	X	X	X	X	X	X	X
MW #56	2								X	X	-	X	X	-	-	X	X	X
MW #57	2								X	X	X	X	X	-	-	X	X	X
MW #58	4								X	X	-	X	X	X	X	X	X	X
MW #59	2								-	-	-	-	-	-	-	-	-	-
MW #60	2								X	X	X	X	X	X	X	X	X	X
MW #61	4								X	X	X	X	X	-	-	X	X	X
MW #62	4								X	X	X	X	X	-	-	X	X	X
MW #64	4	Y							X[a]	X[a]	X[a]	X[a]	X[a]	-	-	X[a]	X[a]	X[a]
MW #65	4	Y							X[a]	X[a]	X[a]	X[a]	X[a]	-	-	X[a]	X[a]	X[a]

[a] Sample to be collected if PSH <0.03 feet thick.

Field gauging form to be updated for each event - one page provided as example only.

Navajo Refinery Monitor Well Sampling Form

Project #: NAV-06-003 **Well ID.:**_____

Date: _____ Time on location: _____

Samplers:_____ Time off location: _____

Measuring Point: _____ Low Flow or pump: _____

Measured Well Depth (W_1):_____ Height of water column (H_1=W_1-W_2):_____

Sample Date Depth to Water: (W_2):_____ Well Diameter: _____

---

* Low flow: New pump tubing each location. Tubing length in well: Height water column $H_1/2 + W_2$. Run 15 minutes minimum. Sample when specific conductance, temperature, DO and turbidity are within 10% of previous reading and pH is within 0.5 pH units.

For 2" wells: One casing volume = 0.163 x H_1 = _____ gallons; 3 casing volumes = _____ gallons
For 4" wells: One casing volume = 0.653 x H_1 = _____ gallons; 3 casing volumes = _____ gallons
For 6" wells: One casing volume = 1.469 x H_1 = _____ gallons; 3 casing volumes = _____ gallons
(Hint: An acceptable short cut:
For 2" wells, take the height of the water column and divide by 2 for three casing volumes.
For 4" wells, take the height of the water column and multiply by 2 for three casing volumes.)
* Sub. Pump: A minimum of 3 casing volumes will be removed prior to sampling unless the well can be bailed/ pumped dry. Sampling should begin after the water level has recovered to at least 75% of its original level.
* Both methods: Measurements of pH, specific conductance, temperature, dissolved oxygen, and ORP will be recorded for each one-half casing volume removed. Should pH, specific conductance, temperature not stabilize; additional casing volumes to a maximum of ten will be removed during purging.

Sample for VOCs(3)___Metals(1)____GRO(3)____DRO(2)____SVOC(2)____Cation/Anions/TDS/NO_3(3)___

Note - For Cation/Anions/TDS/NO_3 check these boxes: Anions/Alk, Cations, TDS, Nitrate/Nitrite

Purging and Sampling Record: To Purge: _____ gallons

No. Gallons	pH (SU)	Cond [units] (_____)	Turb (ntu)	DO (mg/L)	Temp (°C)	ORP (mv)	LF Depth to Water (ft.)

Notes:

Taken at this location: Equipment Blank: _____ Field Blank: _____

Sample Time:

Daily Log Sheet

Date _____

This sheet shall document observations and field activities not otherwise reported on well sampling forms

Date _____